found to have evolved the mechanics for speed of glochidial valve adduction by the use of long out lever arms (*Tritogonia*, *Quadrula pustulosa pustulosa*, and *Amblema plicata plicata*). However, strength was maximized by the use of long lever arm alone (*Magnonaias nervosa*) or by the use of long in lever arms and short out lever arms (*Quadrula cylindrica cylindrica*, and *Fusconaia ebena*) although it is suggested that this is accompanied by disadvantage in the form of reduced gape. This study suggests that the mode of glochidial attachment, whether for speed or strength, has played a large part in glochidial morphology and has produced convergence in valve shape as well as in the location, orientation and size of the glochidial adductor muscle.

PRELIMINARY STUDIES OF DEGROWTH PHYSIOLOGIES IN THE FRESHWATER PULMONATE SNAILS, *HELISOMA TRIVOLVIS* AND *HELISOMA ANCEPS*.
Jonathan Kyung Ho Han and **Jay Shiro Balboni-Tashiro,** Kenyon College, Gambier, Ohio.

A number of studies have examined the physiology and tissue biomass changes in overwintering specimens of the freshwater pulmonate *Helisoma trivolvis* . These studies have included assessments of animals overwintering in the field and maintained under simulated winter conditions in the laboratory (Russell-Hunter and Eversole, 1976, *Comp. Biochem. Physiol.* 54A:447; Russell-Hunter *et al.*,1983 *Comp. Biochem. Physiol.* 74A:491; Russell-Hunter *et al.*, 1984, *Ecology* 65:223). In both field and laboratory settings, there is good evidence for a tissue "degrowth" capacity in individual snails during overwintering conditions. Degrowth has been defined by Russell-Hunter and his colleagues as a decrease in unit mass of structural protein. When specimens of *Helisoma trivolvis* were held in a laboratory regime similar to winter conditions (8° C, no food), snails lost tissue biomass, including structural protein. Tissue degrowth was found in three of the four field populations studied by Russell-Hunter and his co-workers. The oxygen uptake and ammonia excretion rates also have been measured for individuals of *H.trivolvis* kept in laboratory degrowth conditions. These earlier studies provide some indication of the changing proportions of protein carbon and nonprotein carbon which are utilized as substrates in the degrowth physiology of *Helisoma trivolvis*.

Our work complements earlier studies by providing an age-specific experimental design and by including a related species, *Helisoma anceps* . We sampled a *H. trivolvis* population located in the Dawes Arboretum, near Newark, Ohio. Specimens of *H. anceps* were taken from a small spring-fed pond near Gambier, Ohio. Animals were collected in November, 1983, sorted by size and age, and maintained under simulated overwintering conditions in an environmental chamber set at 10°C, with a 14:10 light to dark cycle. Three hundred snails of each species were collected. The experimental design had three major categories of snails. One category was a pre-winter control group that was sacrificed shortly after collection. The other two categories were experimentals, snails that spent time in the laboratory under degrowth conditions. One of these categories was a fed group (offered an artificial food ration designed by Tashiro *et al.*, 1980, Malacol. Rev. 13:87), while snails in the other category were maintained without food. The "fed' and "unfed" groups were further divided into 35-day and 70-day subgroups, this designation representing the amount of time elapsing from the sacrifice of the controls to the sacrifice of a particular experimental subgroup. Finally, each experimental subgroup had old and young snails. The *H. trivolvis* population had one-, two-, and three-year-old animals (based on shell growth lines and size-frequency analysis). The *H. anceps* population had one- and two-year olds. We studied two- and three-year-old specimens of *H. trivolvis* and one- and two-year-old specimens of *H. anceps* . For each individual snail in all control and experimental groups and subgroups, we obtained oxygen consumptions, ammonia excretion, and urea excretion rates. These physiological measurements were made just prior to sacrifice of the animals. We also measured shell length, weighed shell $CaC0_3$, and determined shell-free tissue dry weights. There were no mortalities among the experimental animals.

There was evidence for degrowth in both species, regardless of whether or not food was available. The temperature regime of 10°C may be borderline for feeding activity. From our analysis of respiration rates in specimens of *H. trivolvis*, we conclude that rates in older animals (3-year-olds) decrease over a 70 day period of degrowth, while rates in younger animals (2-year-olds) increase. For *H. anceps*, respiratory rates of older snails (2-year-olds) increase during the degrowth period, but the rates of younger animals (1-year-olds) remained relatively constant during the degrowth regime.

The ammonia excretion patterns of *H. trivolvis* individuals were similar, regardless of age and trophic status. Rates were lower at 35 days, relative to both control values and rates measured at 70 days. In *H. anceps* individuals, there were age-specific and trophic-specific patterns of ammonia excretion. Younger fed animals had higher rates than older animals at the beginning of the experiment (controls) and at the 70-day sacrifice. The general patterns were a gradual increase in excretion rate through time for older animals, but a decrease (0 to 35 days) and then an increase (35 to 70 days) for young animals. In unfed specimens of *H. anceps*, young snails had higher rates of ammonia excretion at the beginning of the experiment and at the 35-day sacrifice.

The patterns of urea excretion were similar in unfed and fed, old and young specimens of *H. trivolvis*. There was a gradual increase in rates of urea excretion over the course of the 70 days of degrowth. For *H. anceps* individuals, urea excretion peaked at the 35-day sacrifice in both fed and unfed groups, but there was no clear age-specificity. Rates of unfed animals were greater than those fed during the experiment.

We conclude that there are clear species-specific and age-specific differences in the degrowth physiologies of *H. anceps* and *H. trivolvis*. Total nitrogen excreted (NH_3-N plus Urea-N) was fairly constant in specimens of *H. trivolvis*. For example, older unfed animals excreted roughly 7 to 10 ng $N \cdot hr^{-1}$ during the course of the experiment, but the proportion of urea excreted increased steadily from negligible amounts

to greater than 60% of the total nitrogen excreted. In older unfed individuals of *H. anceps*, nitrogen excretion was highest in the 35-day sacrifices. In this species, total nitrogen excretion in older unfed animals ranged from roughly 20 ng $N \cdot hr^{-1}$ in controls, to almost 100 ng $N \cdot hr^{-1}$ in 35-day sacrifices, and back to about 45 ng $N \cdot hr^{-1}$ in the 70-day sacrifices. The proportion of nitrogen excreted as urea by older unfed *H. anceps* ranged from 80 to 95 percent and was highest in the 35-day sacrifices.

These preliminary studies provide important evidence for species- and age-specific physiological profiles in two *Helisoma* species. Importantly, and while there is considerable variation between species, our results are consonant with the paradigm that relative to older conspecifics younger snails have higher rates of protein turnover during diapause. Such turnover, whether it be for maintenance repair or for metabolic energy, may shape the age of first reproduction in temperate mollusk species which have an overwintering diapause state.

SOME PHYSICAL ASPECTS OF NAIAD DISTRIBUTION IN MISSOURI. Alan C. Buchanan, Missouri Department of Conservation, Columbia.

The number of species and living specimens of naiades per site was correlated with physiographic region, stream order and gradient, and local soil type, bedrock type, and relief at 598 sites in Missouri. Both number of species per site and number of specimens per site were significantly positively correlated with stream order, and significantly negatively correlated with stream gradient. Neither number of species per site nor number of specimens per site was significantly correlated with physiographic region, or local soil or bedrock type, or local relief. The highest diversity and abundance of naiades occurs in the Missouri Ozarks where limestone and dolomite comprise a significant portion of the bedrock. The lowest diversity and abundance of naiades occurs in western and northern Missouri in areas of highly erosive soils.

DEVELOPMENT OF A HATCHERY FOR COMMERCIALLY IMPORTANT MARINE BIVALVES IN PANAMA. J.W. Ewart[1], J.R. Villalaz[2], J.A. Gomez[2], L. D'Croz[2], and **M.R. Carriker[1].** [1]College of Marine Studies, University of Delaware, Lewes, Delaware, [2]Centro de Ciencias del Mar Y Limnologia, Universidad de Panama, Republica de Panama.

Scientists at the University of Delaware and the University of Panama are working together to establish an experimental hatchery for the production of juvenile clams *Protothaca asperimma*, scallops *Aequipectin circularis* and oysters *Pinctada mazatlantica*, *Ostrea irridescens*. The goal of the hatchery is to produce juvenile bivalves to replenish declining natural populations and to foster the development of bivalve aquaculture among coastal fishing families.

Reproductive cycles of commercially important bivalves in the Bay of Panama are poorly understood and appear to be significantly influenced by coastal upwelling which occurs during the dry season (January-April). Recent results of bivalve spawning trials, histological studies of gonadal development, and assessment of phytoplankton productivity in both natural waters and laboratory cultures are presented.

POPULATION BIOLOGY OF THE PLEUROCERID SNAIL, *LEPTOXIS CARINATA* (BRUG.) IN MARSH CREEK, ADAMS COUNTY, PA. Sherman S. Hendrix, Biology Department, Gettysburg College, Gettysburg, Pennsylvania.

Both living and dead *Leptoxis carinata* (Brug.) were collected monthly from April 1969 to August 1970 using a modified Suber sampler in a tributary of the Potomac River, Marsh Creek, at highway US-30 four miles west of Gettysburg. Each monthly collection consisted of 30 samples of $.05m^2$ and included at least one transect across the stream above, within, and below a small riffle. Water depth, velocity, and bottom type were determined for each sample site. Marsh Creek is a typical piedmont bicarbonate stream with calcium ion ranging from 30-68 ppm, pH 7.3, and a cobble bottom predominating in the sampling habitat.

A total of 4684 live and 3225 dead *L. carinata* were recovered. The population exhibited characteristics similar to that reported by Aldridge (1982). Egg laying commenced in late March, peaked in June, and ceased by early August. Laboratory reared eggs hatched in 15 days at 20-22°C and young snails grew to a mean length of .639 mm in one week. Field collected young attained a length of 4.5 mm by the September collection and exhibited a high mortality rate. *L. carinata* became sexually dimorphic by the following summer. The sex ratio in the population was 1:1.

The digenetic trematode *Plagioporus hypentelii* Hendrix (1973) uses *L. carinata* as its first intermediate host. One and two year old males were found to have a significantly higher incidence of infection (7% vs 3%) than females. Infected individuals were usually found below the riffle. The number of daughter sporocysts in the rectum of *L. carinata* varied seasonally, with the peak in the summer months.

THE FRESHWATER MOLLUSKS OF THE HUDSON RIVER BASIN: A HISTORICAL AND ECOLOGICAL SURVEY. D. Strayer. Institute of Ecosystem Studies, Millbrook, New York.

Except for Smith's recent papers (e.g., *Nautilus* 97: 128-131), the mollusk fauna of the Hudson River basin has received little attention. I am using museum and literature records in conjunction with field surveys to describe the distribution, ecology, and historical changes in status of the freshwater mollusks of the basin.

My survey of museum and literature records is nearly complete. Because of the dedication of a few collectors and the vigilance of several museums (ANSP, UMMZ, USNM, AMNH, MCZ), I was able to locate more than 2000 museum lots, most of them from the 19th century.

The Hudson basin's fauna contains at least 82 species of freshwater mollusks, including 21 unionids, 18 pisidiids, 24 pulmonates, and 19 prosobranchs. As Smith has already pointed out, the Hudson served as a zoogeographic gateway between the Atlantic Slope and the Interior Basin, so its fauna